BRUHATH BENGALURU MAHANAGARA PALIKE

DETAILED PROJECT REPORTS

Name of the Work :- Augmentation of Water Supply throught Borewells , Network of Pipelines and ground water Recharges facilities in areas layouts of Shettyhalli Village. Abbigere Village & Chikkasandra village for Cost of Rs 2.10 Crore.

Civil Aim Consultants & Engineers

(Buildings Geo-Test & Highway Materials Testing Laboratory)

An ISO 9001:2015 Certified Company

NABL Accredited As Per ISO/IEC 17025:2017 Laboratory

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1.0 Introduction :

The water demand is met from a suitable source. This source should satisfy the requirement in terms of quantity as well as quality. The usual sources of supply of water are rivers, canals, lakes, ponds, and wells etc. Railway may have its own arrangement for collecting water or may depend on local government resources for supply of full or partial requirement of water.

It is the responsibility of Civil Engineering Department to arrange adequate supply of water of acceptable quality to Railway premises. To discharge this responsibility, it is essential to assess the requirements of water supply. The yardsticks for assessing the water requirement are laid down in Para 504 of Indian Railways Works Manual (IRWM).

2.0 Availability of water:

The water availability and the associated features and constraints are as follows:

a) **Surface water** – Surface water is water in river, lake or fresh water wetland. Surface water is naturally replenished by precipitation and naturally lost through discharge to the oceans, evaporation, evapo-transpiration and sub-surface seepage. Although the only natural input to any surface water system is precipitation within its watershed, the total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial reservoirs, the permeability of the soil beneath these storage bodies, the runoff characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All these factors also affect the proportions of water lost.

Human activities can have a large impact on these factors. These often include increase in storage capacity by constructing reservoirs and decrease by draining wetlands, increase in runoff quantities and velocities by paving areas and channelizing stream flow. Also surface water may be lost or become unusable through pollution.

b) **Under river flow** – Throughout the course of the river, the total volume of water transported downstream will often be a combination of the visible free water flow together with a substantial contribution flowing through sub-surface rocks and gravels that underlie the river and its floodplain called the hyporheic zone. For many rivers in large valleys, this unseen component of flow may greatly exceed the visible flow. The hyporheic zone often forms a dynamic interface between surface water and ground water, receiving water from the ground water when aquifers are fully charged and contributing water to ground water when ground waters are depleted.

c) **Ground water** - Sub-surface water, or groundwater, is fresh water located in the pore space of soil and rocks. It is also water that is flowing within aquifers below the water table. Sometimes it is useful to make a distinction between sub-surface water that is closely associated with surface water and deep sub-surface water in an aquifer.

Sub-surface water can be understood in the same terms as surface water, i.e. in terms of inputs, outputs and storage. The critical difference is that due to its slow rate of turnover, sub-surface water storage is generally much larger compared to inputs than it is for surface water. This difference causes a tendency to use sub-surface water unsustainably for a long time. However, it should be noted that the natural input to sub-surface water is seepage from surface water and this source is not infinite. However, the input to a sub-surface water source can be increased by building reservoirs or detention ponds.

d) **Desalination** – Desalination is an artificial process by which saline water (generally sea water) is converted to fresh water. The most common desalination processes are distillation and reverse osmosis. Desalination is currently expensive compared to most alternative sources of water. It may be economically viable only for high-valued uses, such as household and industrial uses, in arid areas.

3.0 Aquifers and aquicludes:

The layers of soil and rock below the water table are classified in two broad categories:

- Aquifers
- Aquicludes.

Aquifers are water bearing layers (or formations) that yield water to wells in usable amounts. Typical aquifers are made of sand, gravel or sandstone. These materials have large interconnected pore spaces between grains that water moves freely. Coal and shale are more tightly compacted but may also be suitable aquifer materials if they are fractured enough to allow water to move through them.

Aquicludes are water bearing formations that cannot yield adequate water for wells. Examples of these are clay and un-fractured shale and coal. The pore spaces between grains of these materials are so small that water moves through them extremely slowly.

4.0 Confined and unconfined aquifers

Unconfined aquifers are exposed directly to the atmosphere through openings in the soil. The volume of water in unconfined aquifers is mainly dependent on seasonal cycles of precipitation that refills the aquifer. A water table aquifer is an example of an unconfined aquifer.

A confined aquifer is trapped below an upper confining layer of rock, clay or shale. When a well is drilled into a confined aquifer, the water level in the well rises above the upper boundary of the aquifer. Aquifers that are completely saturated with water and under pressure are called artesian aquifers. A flowing artesian well results when the pressure in the aquifer raises the water level above the ground surface.

In Indian Railway, the common source of water supply is underground water. The underground water is extracted through tubewells.

- **Deep Borewell** : A deep borewell shall be defined as a borewell of depth more than 30m below the ground surface, having casing diameter of 6 inches or more.
- **Shallow Borewell** : These are Borewells less than 30 m deep

The Indian Railways Works Manual does not deal with issues regarding design and construction of borewell. The USSOR also does not contain specifications regarding borewell. This is largely based on relevant IS codes, supplemented by other technical literature on the subjects. Therefore, wherever applicable, the relevant IS Code has been quoted.

One of the main reason of borewell failure is that the necessary design aspects are not properly taken care of and old practices seem to have deteriorated over time. In fact, the flaws in the design of borewells also affect the quality of water: for example, the practice of filling the entire annular space around the casing pipe with a filter pack of pea gravel increases contamination proneness of the borewells due to migration of surface water into the well through the annular spaces of filter media.

5.0 Classification of borewells: Borewells are also classified according to yield as under:

i) **High Capacity Borewell (HCB)** : Borewells of casing pipe diameter 10 or 12 inches and depth >80m with design yield in the range of 20,000gph to 45,000gph.

ii) **Medium Capacity Borewell (MCB)** : Borewells of casing pipe diameter 8 inches and depth >80m with design yield in the range of 10,000gph to 20,000gph.

iii) **Low Capacity Borewell (LCB)** : Borewells of casing pipe diameter 6 inches and depth 30m to 50m with design yield in the range of 1500gph to 5,000gph.

6.0 Common shortcomings in design, construction and management of Borewells:

The main shortcomings observed in design, construction and management practices in borewells are as under:

(i) The design and selection of size of opening and length of the screen, and the size and grading of filter media are of utmost importance as these aspects affects quantity and quality of water and service life of borewell. Coarser formations in aquifers require larger grain size of filter media and larger opening of the screen, and the finer formations require smaller size of filter media and smaller openings in the screen. Design of the screen and the filter media should be decided on the basis of the grain size distribution of the formation in the aquifer at the intake zone and not on the general grading of the formation. Decision on the selection of screen and filter media should not be left to contractor or someone's general experience. The guidelines regarding this aspects are contained in IS 2800 (Part 1): 1991 "Code of Practice for Construction and Testing of Tubewells/borewells", and IS 8110:2000 "Well Screens and Slotted Pipes" – Specifications.

(xi) A borewell should be commissioned immediately after its installation. However the practice of providing the pump house right above the borewell delays the commissioning and pumping test by several months. Room for electrical control panel and chlorination plant may be constructed a short distance (5 to 20m) away from borewell to avoid the delay in commissioning of borewell.

(xii) There is also scope of improvements in other aspects like;

- Proper development of the aquifer after installation of casing pipe and screen.
- Proper estimation of yield and pump capacity by drawing drawdown and recovery curves from pumping tests.
- Proper bacteriological and chemical analysis of water.
- Disinfection of the borewell by shock chlorination before commencing supply, if required.

7.0 Construction of Borewell

The Geological Department or Central Ground Water Board / Public Health Engineering department of the State Government should, be consulted wherever necessary, for proposals of deep tube-wells. Where the "normal-water-table" is at greater depth, it would be economical and preferable to sink deep tube-wells instead of open-wells.

7.01 Selection of Drilling Contractor:

Drilling contractor should have work experience and should know the local geology. Officer/supervisor along with contractor should survey the existing wells in the area as it will provide important information about:

- Typical yields and water quality
- Which aquifer to tap into
- Trends in well design and construction
- Prior drilling success rates.

7.02 Choosing a Well Site:

Choice of well site will affect the safety and performance of well. Most contaminants enter the well either through the top or around the outside of the casing. Sewage or other contaminants may percolate down through the upper layers of the ground surface to the aquifer. It should be ensured that:

- The well is accessible for cleaning, testing, monitoring, maintenance and repair.
- The ground surrounding the well is sloped away from the well to prevent any surface run off from collecting or ponding.
- The well is up-slope and as far as possible from potential contamination sources such as septic systems.

7.03 Trial boring:

Before sinking of pipes, samples of strata are examined for yield and samples of water taken for analysis. From the results obtained, the area of strainer necessary for the quantity of water required and the strata in which the strainers should be located are decided upon.

7.04 Samples of water for analysis:

For a large water supply, water should be drawn from as great a depth as possible to eliminate the danger of bacteriological contamination which can be expected in water drawn from the upper strata. Water drawn from deep ground is likely to be bacteriologically pure. As the water obtained from deep wells may contain certain dissolved impurities, the chemical analysis of water to determine its suitability for drinking is always necessary and samples should be sent for the test.

7.05 Minimum Distance Requirements:

Provincial regulations may outline minimum distance requirements. In absence of those, the following may be considered and borewell should be away by

- 10 m from a watertight septic tank
- 15 m from a sub-surface effluent disposal field or an outdoor pit privy
- 50 m from sewage effluent discharge to the ground surface
- 30 m from pesticide or fertilizer storage
- 50 m from above-ground fuel storage tanks
- 100 m from a manure storage facility or manure collection area or livestock yard
- 100 m from dead animal burial or composting site
- 50 m from the outer boundary of a graveyard
- 450 m from any area where waste is or may be disposed of at a landfill

Borewell design and construction details are determined after a test hole has been completed and the geological zones have been logged. There are many components to well design and decisions should be made about:

- Type of well
- Intended use
- Well depth
- Casing material, size and wall thickness
- Intake design
- Annular seal
- Monitoring and preventive maintenance provisions.

7.06 Selecting Type of Well

There are two main types of wells, each distinguished by the diameter of the bore hole. The two types are bored wells and drilled wells.

Bored wells

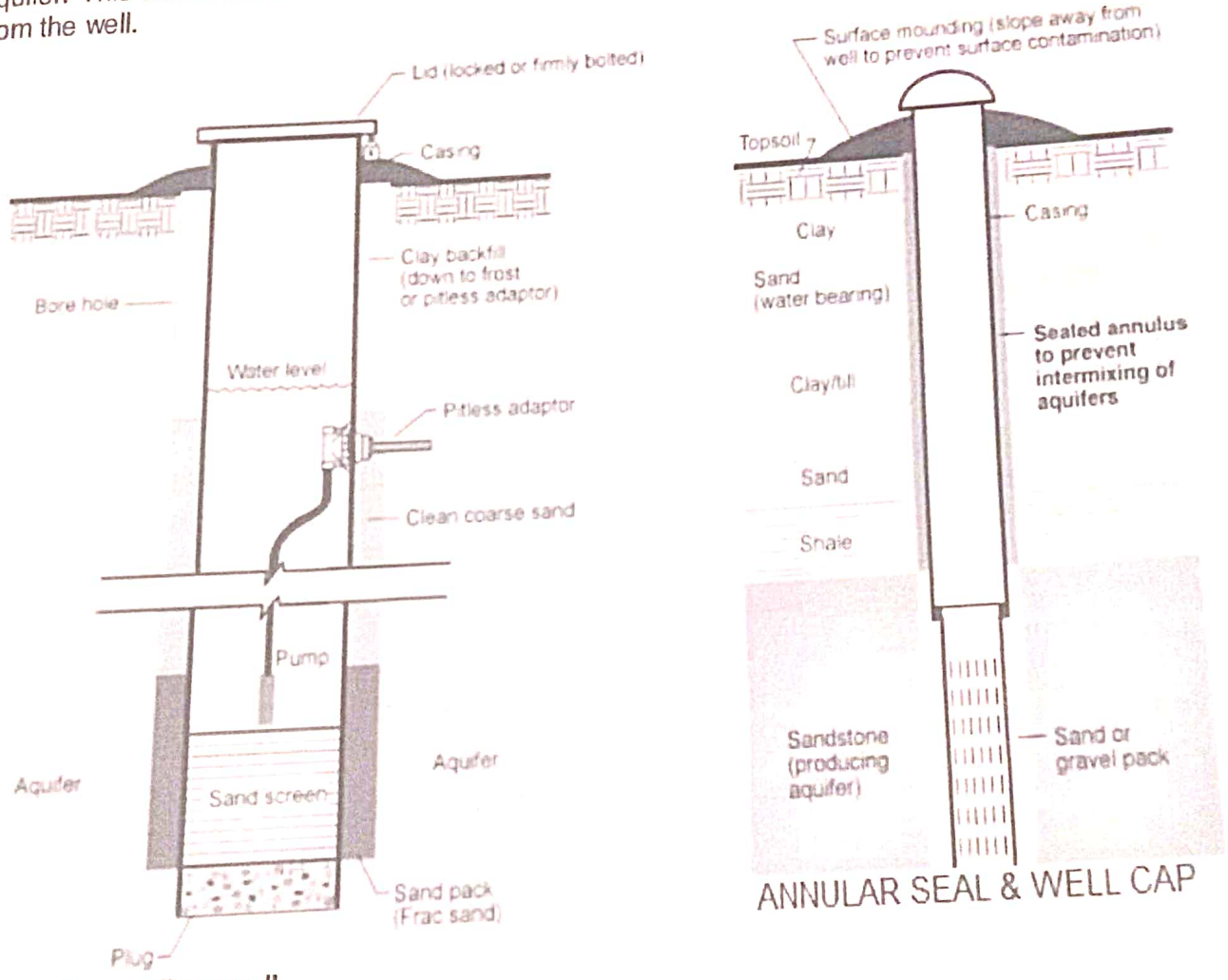
Bored wells are constructed when low yielding groundwater sources are found relatively close to the surface, usually under 30 m (100 ft.). Bored wells are constructed using a rotary bucket auger. They are usually completed by perforating the casing or using a sand screen with continuous slot openings. One advantage of bored wells is the large diameter of the casing, from 450-900mm which provides a water storage reservoir for use during peak demand periods. A disadvantage is of utilizing a shallow groundwater aquifer and water shortages may occur following long dry periods in summer. It is also more susceptible to contamination from surface land-use activities.

Drilled wells

Drilled wells are smaller in diameter, usually ranging from 100-200 mm, [illegible] greater depths than bored wells, up to several hundred metres. The producing aquifer is generally less susceptible to pollution from surface sources because of the depth. Also, the water supply tends to be more reliable since it is less affected by seasonal weather patterns.

7.07 Well Depth

During the test hole drilling, a lithologic or formation log should be prepared. Soil and rock samples are taken at various depths and the type of geologic material is recorded. This help in identifying the zones with the best potential for water supply. Generally a well is completed to the bottom of the aquifer. This allows more of the aquifer to be utilized and ensures the highest possible production from the well.



Construction of Borewell

Casing Size and Type

The casing must be large enough to house the pump and should allow sufficient clearance for installation and efficient operation. Casing of one nominal size larger than the outside diameter of the pump is sufficient. There are two common materials used for casing: steel and plastic. Steel casing is the strongest but is susceptible to corrosion. Plastic casing is becoming more popular because of its resistance to corrosion. All casing must be new and uncontaminated. Plastic casing must be made of virgin resin, not recycled material.

7.09 Intake Design

Water moves from the aquifer into the well through either a screen or slotted or perforated casing. Screens are manufactured with regularly shaped and sized openings. They are engineered to allow the maximum amount of water in with minimal entry of formation sediments. Stainless steel screens are preferred because they are strong and relatively able to withstand corrosive water. Pre-slotted plastic pipe are also used as they are economical. Screens are manufactured with various slot sizes and shapes to match the characteristics of the aquifer. A good screen should allow the flow of water into the well and should be effective in holding back the formation sediments.

Cuttings from the borehole should be examined and a judgment should be made whether to use a screen, or slotted or perforated casing/liner. While a screen is the more expensive alternative, it is necessary if the aquifer is composed of loose material such as fine sand, gravel or soft sandstone. A slotted or perforated casing/liner can be used when the aquifer formation is more consolidated, such as hard sandstone or fractured shale.

Slot / screen size openings

The slot openings must be small enough to permit easy entry of water into the well while keeping out sediment. The slot size chosen will depend on the particle size of the earth materials in the producing aquifer. Typically one should select a slot size that allows 60 percent of the aquifer material to pass through during the well development phase of drilling. The remaining 40 percent, comprising the coarsest materials, will form a natural filter pack around the perforations or screen.

Total open area of screen

The amount of open area in the screen or slotted or perforated casing/liner will affect how quickly the water from the aquifer enters the well. A larger amount of open area allows the water to enter the well at a slower rate, causing a lower drop in pressure as the water moves into the well. If the water flows too quickly, dissolved minerals in the water will precipitate out of solution and create an incrustation build-up in restricting the flow of groundwater into the well. Incrustation is a buildup that occurs when dissolved minerals in the groundwater come out of solution and deposit on the screen or casing. The pore spaces in the aquifer immediately adjacent to the perforations may also get plugged, restricting the flow even more.

The total area of the slot openings is dependent on the length and diameter of the screen. While the length of the screen is variable, the diameter of the screen is determined by the diameter of the well casing. The yield from a well increases with an increase in screen diameter but not proportionately.

Placement in the aquifer

The screen or perforations on the casing/liner must be placed adjacent to the aquifer. If improperly placed, the well may produce fine sediment which will plug plumbing fixtures and cause excessive wear on the pump. Therefore bore log data should be analyzed to accurately identify the boundaries of the aquifer for exact placement.

7.10 Verticality of Tube Wells

Tubewells must be perfectly vertical. A simple method is to use plumb disk. Two disks made out of 3mm thick steel plate are connected together by a rod of 25mm diameter and 3 m long tightened with the help of nuts at the ends. Some holes are punched in plates to facilitate immersion in water.

A knob is fixed on the top nut to which a thin steel wire is attached. The disk is suspended into the tube by the wire passing over a pulley on a tripod. When the disk is lowered into the pipe, the wire is exactly in the centre of pipe. When the disks are further lowered down and if the well pipe is not truly vertical, the wire will deviate from the centre and that shall be indicated at the top of pipe.

Absolute verticality is ideal but a deviation of 100mm per 30 metres of boring is generally acceptable where submersible pumps are not to be installed.

7.11 Annular Seal & Well cap

Sealing the well protects the well from contamination. The diameter of the borehole is usually slightly larger than the casing. The space between the borehole and the casing is called the annular space. It must be sealed to prevent any surface contamination from migrating downward and contaminating the water supply.

A commercially manufactured, vermin-proof well cap is designed to keep animals, insects and contaminants from entering the well. It comes equipped with rubber gaskets and screened vents to ensure air circulation. Coverings for large diameter wells must be custom made because of their larger size. Ideally they should be made of steel, or fiberglass or plastic.

7.12 Well Completion

Once the well has been drilled and the equipment is in place, there are three more steps that should be completed before the well is ready to use. These are:

- Developing the well.
- Conducting a yield test.
- Disinfecting the well.

7.12.1 Well Development

Well development is the process of removing fine sediment and drilling fluid from the area immediately surrounding the perforations. This increases the well's ability to produce water and maximize production from the aquifer. If the aquifer formation does not naturally have any relatively coarse particles to form a filter, it may be necessary to install an artificial filter pack. This pack is placed around the screen or perforations so the well can be developed. For example, this procedure is necessary when the aquifer is composed of fine sand and the individual grains are uniform in size. It is important to match the grain size of the filter pack material with the size of the slot openings of the screen to attain maximum yield from the well. Typically the slot size of the screen is selected so that 85 percent of the artificial pack material will remain outside of the screen after well development.

7.12.2 Yield Test

A yield test is important because it gives the information of:

- Rate at which to pump the well
- Depth at which to place the pump.

After drilling and developing a well, one must remove water from the well for at least 2 hours. If a pump is used to remove the water, then water level measurements can be recorded as the water

level draws down during pumping. If the yield test is performed using an air compressor to remove the water, water level measurements cannot be taken during the water removal portion of the test.

After 2 hours, water removal should be stopped and the recovery of the water level monitored and recorded. Measurements must be taken at specific time intervals for a 2 hour period or until the water level returns to 90 percent of its original level. Once the yield test is complete, it can be decided at what rate the well can be pumped without lowering the water level below the top boundary of the aquifer, the top of the perforations or below the pump intake.

This also help in deciding the pump capacity as pump should have a capacity equal to, or less than, the rate at which the well can supply water for an extended period of time without lowering the water level below the pump intake. That pumping rate is considered the long-term, safe and sustainable pumping rate for the well.

A tubewell should be tested for yield by experienced staff as per IS:2800-1979.

7.12.3 Disinfecting the well

New well should be disinfect with chlorine. The concentration must be at least 200 milligrams of chlorine per litre of water present in the well and must be left in the well for at least 8-12 hours to ensure any bacteria present are destroyed.

8.0 DESIGN CONSIDERATIONS FOR BOREWELLS:

8.1 Naturally developed borewells and borewells with filter pack :

In aquifers of silts and sands, borewells shall be provided with a filter pack, but in aquifers having gravelly sands, sandy gravel and gravel with D_{10} (grain size to which 10% of the formation material finer) more than 0.3mm and uniformity coefficient more than 5 (D_{60} / D_{10} >5) gravel pack shall not be provided and such wells shall be naturally developed to create a graded zone at the screen in the intake zone.

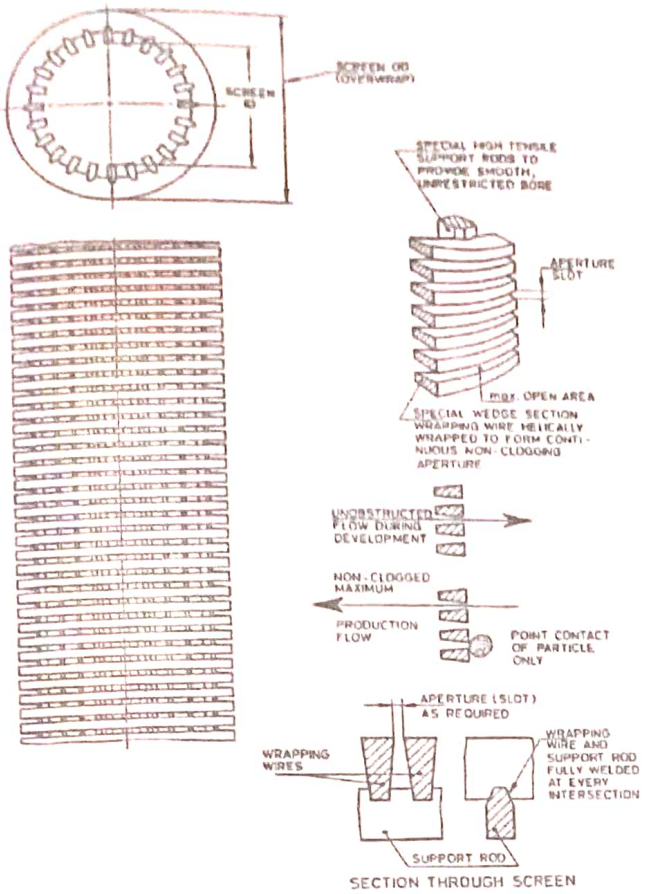
8.2 Design Yield:

So that good discharge is achieved even under continuous pumping, borewells shall be designed for a rate of discharge 25% more than the required rate of discharge.

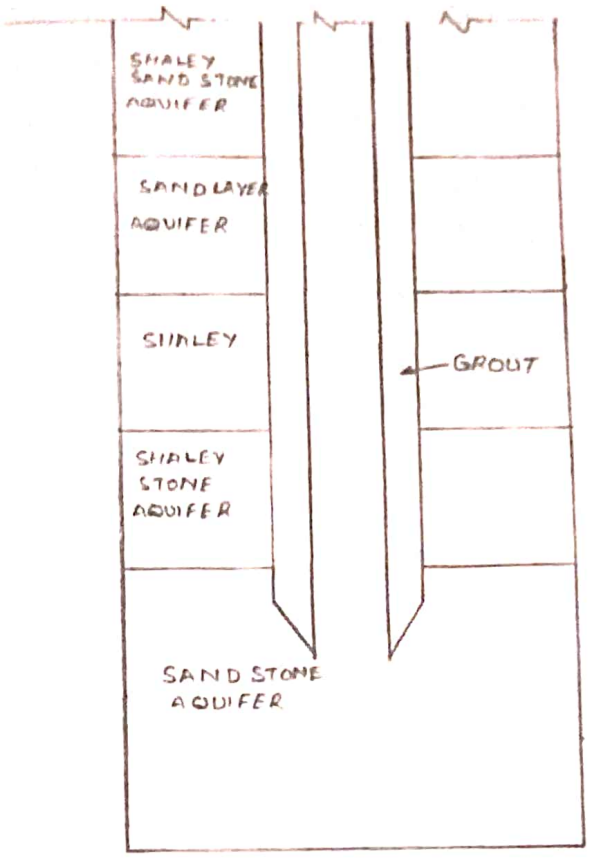
8.3 Annular Space:

The annular space between the bore and the casing pipe shall be as follows:

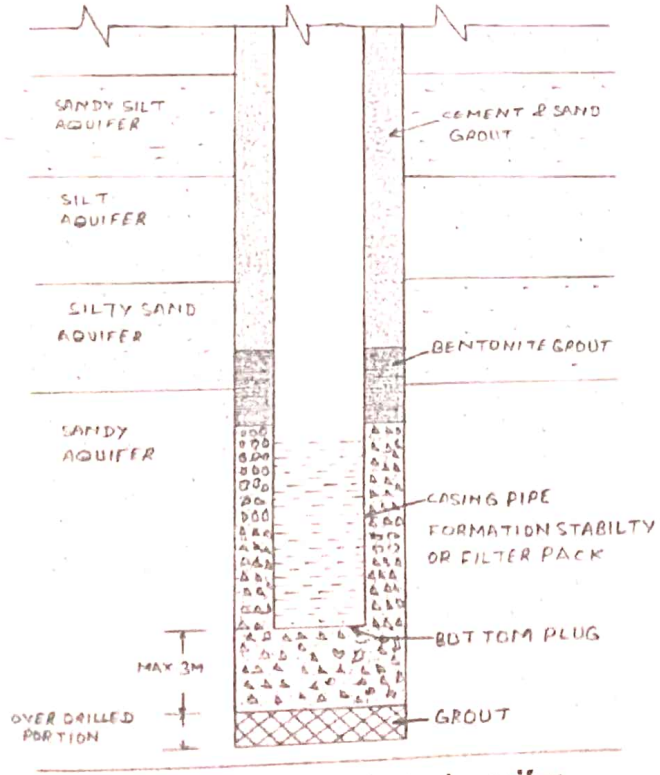
Type of Borewell	Depth of Borewell	Thickness of Annular Space	Diameter of bore hole
Borewells with filter pack	Less than 125m	3"	D+6"
	125 to 250m	4"	D+8"
	More than 250m	6"	D+12"
Naturally developed borewells without gravel pack	Less than 125m	1"	D+2"
	More than 125m	1½"	D+3"


SCREEN OD (OVERWRAP)
SCREEN ID
SPECIAL HIGH TENSILE SUPPORT RODS TO PROVIDE SMOOTH, UNRESTRICTED BORE
APERTURE SLOT
max. OPEN AREA
SPECIAL WEDGE SECTION WRAPPING WIRE HELICALLY WRAPPED TO FORM CONTINUOUS NON-CLOGGING APERTURE
UNOBSTRUCTED FLOW DURING DEVELOPMENT
NON-CLOGGED MAXIMUM
PRODUCTION FLOW
POINT CONTACT OF PARTICLE ONLY
APERTURE (SLOT) AS REQUIRED
WRAPPING WIRES
WRAPPING WIRE AND SUPPORT ROD FULLY WELDED AT EVERY INTERSECTION
SUPPORT ROD
SECTION THROUGH SCREEN

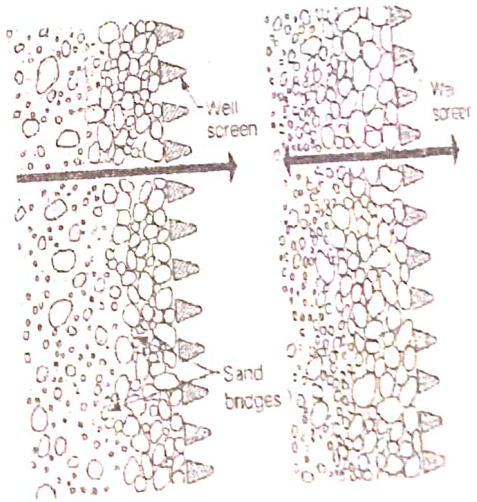
Cage type wire wound screen



Intake zone in a rock aquifer



Intake zone in a unconsolidated aquifer



Development of the aquifer to form a graded zone around the screen

9.0 Classification of formation material:

Classification of formation shall be done according to the Unified Classification System, using nomenclature such as "well-graded sandy gravel, poorly-graded sand, well-graded silty, sandy gravel sandy, clay of medium plasticity" etc. If it is not possible to accurately assess the grain size and grading of the formation and the yield of the aquifer, the values of yield, slot size, grading of filter pack and screen length given in Table-I, Table-II and Table-III below may be adopted which will also be used for preliminary design of the borewell.

TABLE- I

(For HCB and MCB Class borewells with filter pack)

Formation of Aquifer	Design Yield	Nominal diameter of casing pipe	Filter Pack	Length of the screen	Type of Screen	Slot size of Screen
Clayey sandy silt, and sandy silt D_{85} = Less than 0.08 mm	10,500 to 16,000 GPH	200mm	0.2 mm to 0.6 mm	15 to 20 m	Preferably cage type wire-wound slotted pipe may also be used	0.25 mm (10% open area)
Silty sand D_{85} = 0.08 to 0.24 mm	13,500 to 20,000 GPH	200mm	0.6 mm to 1.6 mm	10 to 15 m	Preferably cage type wire-wound slotted pipe may also be used	0.50 mm (18% open area)
Silty Sand, Sand D_{85} = 0.24 to 0.8 mm	23,000 to 35,000 GPH	250 mm	2.0 mm to 4.75 mm	10 to 15 m	Case type wire wound screen	1.0 mm (25% open area)
Sand and gravelly sand D_{85} = 0.8 to 1.6 mm	30,000 to 45,000 GPH	250mm	3.35 mm to 8.0 mm	10 to 15 m	Case type wire wound screen	1.5 mm (33% open area)

TABLE-II

(For naturally developed HCB and MCB Class borewells without filter pack)

Formation	Design Yield	Nominal diameter of casing pipe	Length of the screen	Type of Screen	Slot size
Gravelly sand D_{50} >0.9 to 1.25 mm	23,000 to 35,000 GPH	250mm	10 to 15 m	Cage type wire wound screen	1.0mm (25% open area)
Sandy gravel and gravel D_{50} >1.25 to 1.75 mm	30,000 to 45,000 GPH	250mm	10 to 15 m	Cage type wire wound screen	1.5mm (33% open area)
Sandy gravel and gravel	30,000 to 45,000	250 mm	8 to 12 m	Cage type wire wound screen	2 mm (40% open area)

TABLE-III

(For LCB Class borewells)

Formation	Design Yield	Type of Screen	Length of screen	Slot size
Silty sand D_{50} < 0.25mm	1,500 to 2,000 GPH	Slotted pipe	2.0 m to 3.0 m	0.25 mm (10% open area)
Sand D_{50} = 0.25 to 0.5 mm	2,000 to 3,000 GPH	Slotted pipe	1.5 m to 2.5 m	0.50mm (18% open area)
Sand D_{50} > 0.5 mm	3,000 to 5,000 GPH	Cage type wire wound	1.50 m to 2.5 m	1.0mm (30% open area)

Notes regarding Tables I, II and III:

i) If the open area of the screen is more or less than the figure in the last column in the above tables, length of screen shall be proportionately increased / decreased.

ii) The actual yield may be lower than those indicated in the tables above in places with poor aquifers and due to factors like a low rainfall area.

iii) A casing pipe of a 200 mm diameter can be used in place of 250mm and a 250 mm diameter pipe can be used in place of 200mm provided the length of the screen is proportionately increased/reduced.

10.0 Sanitary seal and sealing of intake aquifer:

All drinking water borewells shall be properly sealed to prevent migration of surface water into the intake aquifer, and in case of confined aquifers sealing shall be done to also prevent migration of water from aquifer above the confining layer in to the lower intake aquifer. A confined aquifer is a layer of thickness more than 3m of the clay, silty clay or sandy clay with vertical hydraulic conductivity $<10^{-6}$ m/sec.

There will be three type of seals:

i) Neat cement grout near the top of the well, and at the confining layer.

ii) bentonite pellet seal just above the filter pack (Bentonite pellets expand several times over when wet and thereby fill up the space created due to settling of the filter media during development), and

iii) cement-sand grout in the intermediate space. Details are shown in figure 3. Neat cement grout shall be prepared by mixing 50kg of cement in 26.63 liter of water. Bentonite powder shall be added to cement in the ratio of 3% to reduce shrinkage cracks. The grout so prepared shall have a volume of 33 liters. Bentonite pellets shall be emplaced using tremie pipe of inside diameter 1-1/2 inches. Neat cement grout and cement sand grout shall also be emplaced using tremie pipe. Grouts generate substantial heat during hydration. So in bore wells of PVC pipe casing, precautions should be taken to prevent melting of the pipe.

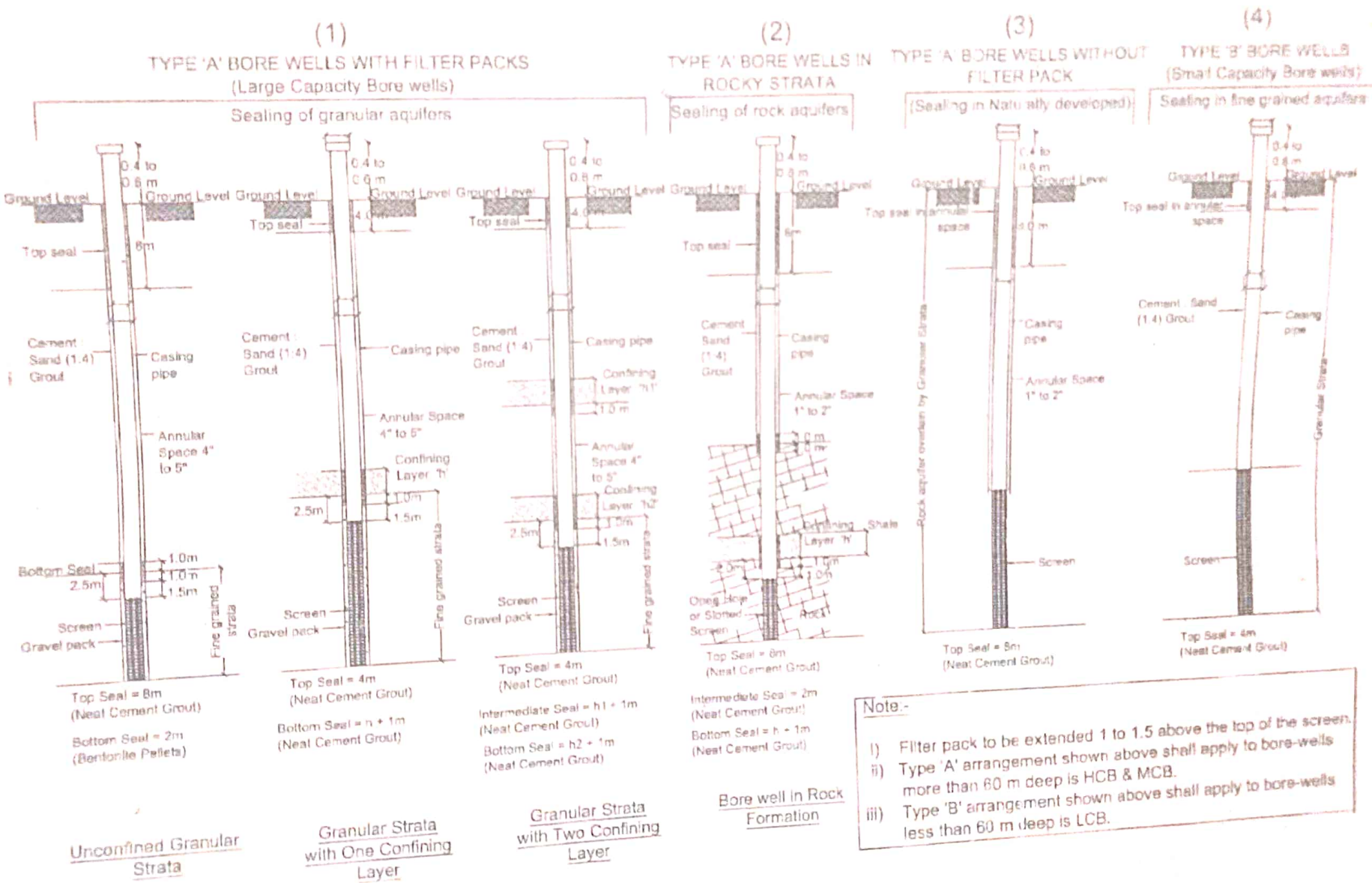
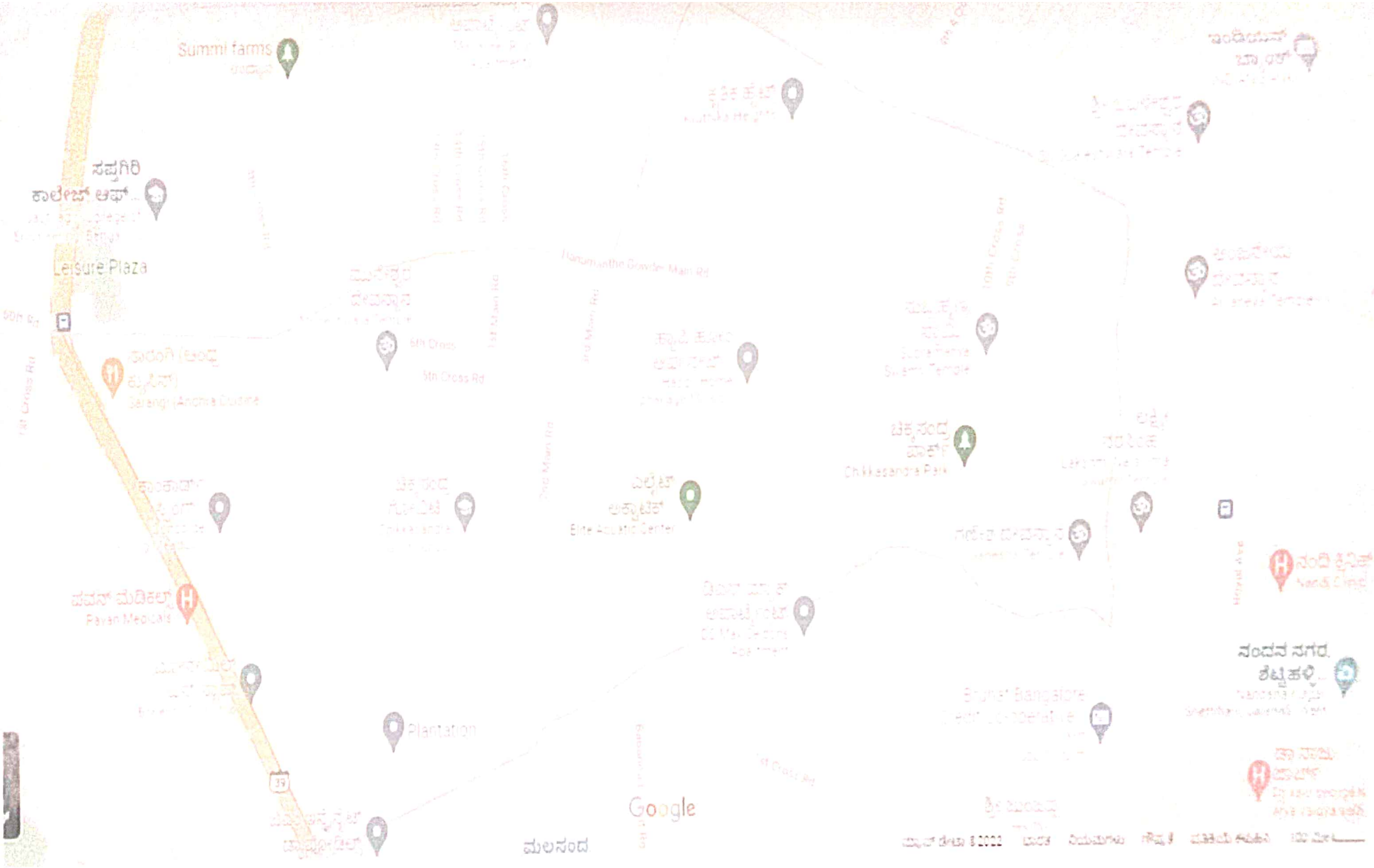

(1)
TYPE 'A' BORE WELLS WITH FILTER PACKS
(Large Capacity Bore wells)
Sealing of granular aquifers
(2)
TYPE 'A' BORE WELLS IN ROCKY STRATA
Sealing of rock aquifers
(3)
TYPE 'A' BORE WELLS WITHOUT FILTER PACK
(Sealing in Naturally developed)
(4)
TYPE 'B' BORE WELLS
(Small Capacity Bore wells)
Sealing in fine grained aquifers
Ground Level
Top seal
Cement : Sand (1:4) Grout
Casing pipe
Annular Space 4" to 5"
Annular Space 1" to 2"
Confining Layer 'h'
Confining Layer 'h1'
Confining Layer 'h2'
Bottom Seal 2.5m
Screen
Gravel pack
Fine grained strata
Granular Strata
Rock aquifer overlain by Granular Strata
Top Seal = 8m (Neat Cement Grout)
Bottom Seal = 2m (Bentonite Pellets)
Top Seal = 4m (Neat Cement Grout)
Bottom Seal = h + 1m (Neat Cement Grout)
Intermediate Seal = h1 + 1m (Neat Cement Grout)
Bottom Seal = h2 + 1m (Neat Cement Grout)
Intermediate Seal = 2m (Neat Cement Grout)
Bottom Seal = h + 1m (Neat Cement Grout)
Open Hole or Slotted Screen
Shale
Rock
Unconfined Granular Strata
Granular Strata with One Confining Layer
Granular Strata with Two Confining Layer
Bore well in Rock Formation
Note:-
i) Filter pack to be extended 1 to 1.5 above the top of the screen.
ii) Type 'A' arrangement shown above shall apply to bore-wells more than 60 m deep is HCB & MCB.
iii) Type 'B' arrangement shown above shall apply to bore-wells less than 60 m deep is LCB.

Fig.A: SCHEME FOR SEALING OF BORE-WELLS

LOCATIONS



Chikksandra Surrounding Area

Abhigere Surrounding Area

Shettyhalli Surrounding Area